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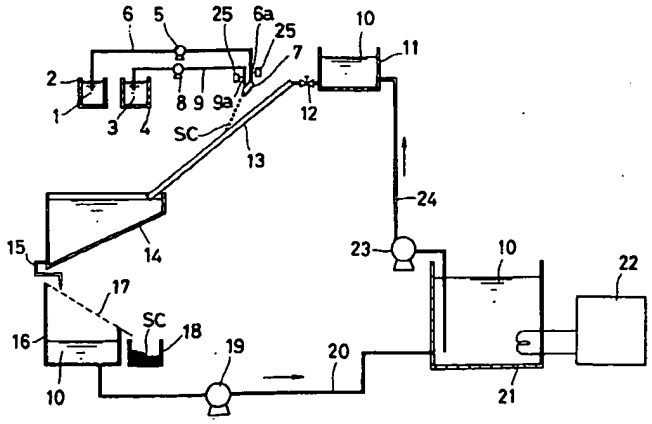
(54) Apparatus for manufacturing seamless capsules.

(57) An apparatus for manufacturing seamless capsules, wherein a multi-layer liquid flow is blown out of a multiple nozzle 7 to form multi-layer droplets which are brought into contact with hardening liquid 10, to thereby manufacture the seamless capsules SC. Parts of pipings 6 and 9 for supplying the liquid flow for forming the capsules to the multiple nozzle 7 are formed of a flexible material, and flexible portions 6a and 9a thus formed are vibrated by a vibrator 25, to thereby form the multi-layer droplets.

FIG. 1



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BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a technique of manufacturing seamless capsules, and particularly to an apparatus for manufacturing seamless capsules from droplets formed by blowing a liquid flow out of a nozzle.

2. Related Art Statement

Out of techniques of manufacturing capsules with no seams in coating layers thereof, i.e., seamless capsules, particularly as a technique suitable for manufacturing capsules smaller in size than an ordinary soft capsule and larger than a microcapsule, such a method is widely known that a multi-layer liquid flow is blown out into air or liquid from a multiple nozzle such as a double nozzle and a triple nozzle to form multi-layer droplets, and the outermost layer liquid of the multi-layer droplets is caused to react with hardening liquid, to thereby obtain a seamless capsule, in which liquid in an inner layer is enclosed.

Furthermore, there has been used such a method that outer portions of single layer droplets, which are formed by use of a single nozzle, are solidified in hardening liquid, to thereby manufacture a seamless capsule with a single layer.

In these cases, it is usual that, in order to obtain capsules having uniform particle diameters, a liquid flow is formed into droplets while vibrations are given to capsule forming liquid.

For example, techniques of forming seamless capsules while a multiple nozzle itself is vibrated are disclosed in Japanese Patent Laid-Open Nos. 57-19032 and 59-112833.

Furthermore, a technique of vibrating a single nozzle itself is disclosed in Japanese Patent Laid-Open No. 59-112831.

Further, a technique of manufacturing seamless capsules by vibrating a ring when a liquid flow for forming seamless capsules blown out of a nozzle is caused to pass through the interior of the ring, is disclosed in Japanese Patent Publication No. 53-1067 for example.

However, the inventors of the present invention have found that the above-described conventional techniques of the nozzle vibration system and the ring vibration system present the following disadvantages, respectively.

That is, as the disadvantages of the conventional nozzle vibration system, the following (1) to (3) are listed.

(1) The mass of the nozzle is large, whereby a vibrating source requires large energy and a large-sized apparatus for manufacturing seamless capsules is needed. Furthermore, for this reason, it is difficult to shut off the vibrations, whereby vibrations are transmitted to other portions, thus causing the turbulence of droplets.

(2) Unless the amplitude of vibration exceeds a certain value, the effect of vibration cannot be expected. However, it is difficult to increase the frequencies with holding the large amplitude of vibration.

(3) In an in-liquid nozzle type, it is usual that a hardening liquid system constitutes a closed system. In this case, the connection between a nozzle and a vibrator is difficult.

Next, as the disadvantage of the ring vibration system, the following (a) and (b) are listed.

(a) The flow of the hardening liquid is made turbulent by the vibrations, whereby dropping of the droplets is made turbulent, thus causing an accident that the droplets strike against the ring.

(b) Similarly to the disadvantage (3) of the above-described nozzle vibration system, the connection between the ring and the vibrator is difficult.

An object of the present invention is to provide a technique of manufacturing seamless capsules, in which a small-sized vibrator suffices and adverse influence of undesirable vibrations can be prevented.

Another object of the present invention is to provide a technique of manufacturing seamless capsules, in which the connection between the vibrator and the vibrating portion is easily made and the both members are provided close to each other.

A further object of the present invention is to provide a technique of manufacturing seamless capsules, in which the frequencies of the vibrated portion can be increased and seamless capsules having minute particle diameters can be manufactured.

SUMMARY OF THE INVENTION

Out of the inventions disclosed in the present application, outline of typical one will be described briefly in the following.

That is, in an apparatus for manufacturing seamless capsules according to the present invention, at least a part of a piping for supplying a liquid flow for forming the capsules into a nozzle is formed of a flexible material, whereby vibrations are given to the flexible portion.

With the above-described apparatus for manufacturing seamless capsules according to the present invention, by vibrating the flexible portion of the piping, the liquid flow blown out of the nozzle is formed into uniform droplets, whereby the desirable seamless capsules can be manufactured, and

moreover, in a vibrating device for vibrating the flexible portion of the piping, the mass of the flexible portion of the piping is small as compared with the mass of the nozzle, so that the vibrating device can be made small-sized and, by increasing the frequencies, the seamless capsules having minute particle diameters can be produced.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and features of the present invention will become apparent when referred to the following descriptions given in conjunction with the accompanying drawings, wherein like reference numerals denote like elements, and in which:

Fig. 1 is a schematic explanatory view showing one embodiment in which the present invention is applied to the apparatus for manufacturing seamless capsules of an in-air nozzle type;

Fig. 2 is an enlarged partial view showing one embodiment of a piping vibrating construction forming the essential portions in Fig. 1;

Fig. 3 is an enlarged partial view showing another embodiment of the piping vibrating construction according to the present invention;

Fig. 4 is an enlarged partial view showing a further embodiment of the piping vibrating construction according to the present invention;

Fig. 5 is an enlarged partial view showing further another embodiment of the piping vibrating construction according to the present invention;

Fig. 6 is an enlarged partial view showing more another embodiment of the piping vibrating construction according to the present invention;

Fig. 7 is an enlarged partial view showing still another embodiment of the piping vibrating construction according to the present invention;

Fig. 8 is an enlarged partial view showing still more another embodiment of the piping vibrating construction according to the present invention; and

Fig. 9 is a schematic explanatory view showing one embodiment in which the present invention is applied to the apparatus for manufacturing seamless capsules of an in-liquid nozzle type.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, in the apparatus for manufacturing seamless capsules of the in-air nozzle type as shown in Fig. 1, core liquid (inner layer liquid) 1 for forming the seamless capsules is stored in a core liquid tank 2 and encapsulating liquid (outer layer liquid) 3 is stored in an encapsulating liquid tank 4.

The core liquid 1 flows from the core liquid tank 2, passes through a piping 6 and is delivered under pressure to a multiple nozzle 7, while the encapsulating liquid 3 flows from the encapsulating liquid tank 4, passes through a piping 9 and is delivered under pressure to the multiple nozzle 7 by a pump 8.

Then, by vibrating parts of the pipings 6 and 9 as will be described hereunder, the core liquid 1 and the encapsulating liquid 3 are blown out of the multiple nozzle 7 in the air and produced as multi-layer droplets, and dropped into hardening liquid which will be described hereunder, thus providing seamless capsules SC of multi-layer droplet type.

Furthermore, the hardening liquid 10 for solidifying the multi-layer droplets blown out of the multiple nozzle 7 during the processes of manufacturing the seamless capsules SC is stored in a hardening liquid tank 11, caused to flow out at a predetermined flow rate into an inclined groove (hardening liquid flow course) 13 having U-shaped section through a valve 12 and flows down into a recovering tank 14.

A pipe 15 is connected to a bottom portion of the recovering tank 14. The seamless capsules SC recovered into the recovering tank 14 flow together with the hardening liquid 10 out of the bottom portion of the recovering tank 14 into a separating tank 16 through the pipe 15.

A slant perforated member 17 is provided on the top of the separating tank 16. This slant perforated member 17 is of a perforated construction having perforations having dimensions not permitting the seamless capsules SC caused to flow out of the pipe 15 to pass therethrough, whereby the seamless capsules SC flowing down onto the slant perforated member 17 move on the inclined surface of the slant perforated member 17, turning around forwardly, and are recovered into a product recovering vessel 18.

On the other hand, the hardening liquid 10 flowing down from the pipe 15 onto the slant perforated member 17 passes through the perforations of the slant perforated member 17 and flows down into the separating tank 16.

The hardening liquid 10 in the separating tank 16 passes through a piping 20 and is delivered under pressure to a cooling tank 21 by a pump 19. The hardening liquid 10 in the cooling tank 21 is cooled to a predetermined temperature by a cooler 22, and thereafter, returned into the hardening liquid tank 11 through a piping 24 by a pump 23.

Now, in this embodiment, such a construction is adopted that the parts of the pipings 6 and/or 9 are vibrated for forming the droplets instead of vibrating the multiple nozzle 7 as known in Prior Art. In connection with this, the piping 6 is described in detail as a typical example.

That is, in this embodiment, a part of the piping

6, e.g., a part close to the multiple nozzle 7, is formed of a flexible material such for example as rubber, plastics or a thin metallic plate as a flexible portion 6a.

Then, a vibrator 25 is connected to this flexible portion 6a which is vibrated by the vibrator 25 at predetermined frequencies and amplitude.

Accordingly, in this embodiment, the core liquid 1 and the encapsulating liquid 3 supplied into the multiple nozzle 7 from the core liquid tank 2 and the encapsulating liquid tank 4 through the pipings 6 and 9 by the pumps 5 and 8, respectively, are given the vibrations by the vibrators 25 at the flexible portions 6a and 9a of the pipings 6 and 9, and formed into the droplets having desirable dimensions when they are blown out of the multiple nozzle 7.

Particularly, in the case of this embodiment, the flexible portions 6a and 9a of the pipings 6 and 9 have the masses smaller than the mass of the multiple nozzle 7, so that the small-sized vibrators 25 suffice, and also, the connecting portions between the flexible portions 6a, 9a and the vibrators 25 can be provided easily at positions close to each other respectively.

Furthermore, the flexible portions 6a and 9a have such an allowance that the frequencies can be made larger than that of vibrating the multiple nozzle 7, so that more minute seamless capsules can be produced.

Incidentally, Figs. 2(a) to 2(c) also show examples of the directions of the vibrating when the vibrations are given to the flexible portion 6a of the piping 6 by the vibrator 25 according to the present invention.

That is, as indicated by arrows, Fig. 2(a) shows a case where the vibration is given to the flexible portion 6a in a direction that intersects the piping 6 (at the right angle or obliquely); Fig. 2(b) shows a case where the vibration is given in a direction identical with the piping 6 or in a direction of expansion and contraction of the portion 6a; and Fig. 2(c) shows a case where the vibration is given in directions that intersect the piping from opposite sides, by repeating the compression and release synchronously.

Fig. 3 is the enlarged partial view showing another embodiment of the piping vibrating construction according to the present invention.

In this embodiment, such a construction is adopted that an ovally bulged portion (deformed portion) 6b is provided on the flexible portion 6a of the piping 6 and the vibration is given to this bulged portion 6b by the vibrator 25 in a direction that intersects the piping 6 at this bulged portion 6b. Due to the presence of the bulged portion 6b, the efficient vibration of a large amplitude can be given.

Fig. 4 is the enlarged partial view showing a further embodiment of the piping vibrating construction according to the present invention.

In this embodiment, such an arrangement is adopted that the flexible portion 6a of the piping 6 is connected thereto with a hollow spherical portion (deformed portion) 6c made of the same flexible material as that of the flexible portion 6a, and this spherical portion 6c is vibrated from opposite directions by two vibrators 25 and 25 which are opposed to each other, synchronously.

In the case of this embodiment, the vibration repeating the compression and release is given to the spherical portion 6c, so that the desirable vibration is obtained by the small-sized vibrators 25 and the satisfactory droplets can be produced.

Fig. 5 is the enlarged partial view showing another embodiment of the piping vibrating construction according to the present invention.

In the embodiment shown in Fig.5, such an arrangement is adopted that a hollow drum-shaped flexible portion (deformed portion) 6d made of flexible material is provided in a part of the piping 6, and the flexible portion 6d is vibrated by repeating the compression and release from opposite directions as indicated by arrows for example.

In this embodiment also, due to the presence of the hollow drum-shaped flexible portion 6d, the desired vibrating can be carried out.

Fig. 6 is the enlarged partial view showing another embodiment of the piping vibrating construction in the present invention.

In this embodiment, a substantially bellows-shaped flexible portion (deformed portion) 6e is provided in a part of the piping 6.

Due to the construction of bellows of this flexible portion 6e, if the vibrations by repeated compression and release in the opposing directions of the axial direction are given to this flexible portion 6e, then the flexible portion 6e is easily vibrated and the satisfactory vibration can be carried out.

Fig. 7 is the enlarged partial view showing another embodiment of the piping vibrating construction according to the present invention.

In this embodiment, in a part of the piping, there are provided a cup-shaped expanded portion 6f made of a non-flexible material and a curved diaphragm-shaped flexible portion (deformed portion) 6g made of a flexible material opposed to this expanded portion 6f.

Fig. 8 is the enlarged partial view showing still another embodiment of the piping vibrating construction according to the present invention.

In this embodiment, a diaphragm-shaped flexible portion 6h as being a part of the pipings 6 and 9 is directly connected to the multiple nozzle 7.

In this embodiment, it is possible to give very highly efficient vibrations by the vibrating in the

axial direction from the vibrator 25.

Next, Fig. 9 is the schematic explanatory view showing one embodiment in which the present invention is applied to the apparatus of the in-liquid nozzle type.

In the embodiment shown in Fig. 9, same reference characters designate elements corresponding to those in the embodiments shown in Figs. 1 to 8, so that repeated description may be omitted.

The apparatus for manufacturing seamless capsules in the embodiment shown in Fig. 9 has the construction of the in-liquid nozzle type, whereby, such an arrangement is adopted that the multiple nozzle 7 is inserted into an inlet portion of a main flow course pipe 26 consisting of a main flow course for supplying the hardening liquid 10, and the nozzle 7 blows out the core liquid 1 and the encapsulating liquid 3 into the hardening liquid 10 so that the encapsulating liquid 3 covers the whole periphery of the core liquid 1.

Further, in this embodiment, such an arrangement as shown in the embodiment of Fig. 8 is adopted that the flexible portion 6h of the pipings 6 and 9 is directly connected to the multiple nozzle 7 and vibrated by the vibrator 25.

Accordingly, in this embodiment, the core liquid 1 and the encapsulating liquid 3, which are blown out of the multiple nozzle 7, are formed into multi-layer droplets in the hardening liquid 10 in the main flow course pipe 26 by the vibrations given to the flexible portion 6h of the piping 6 and 9 by the vibrator 25, and are solidified by the agency of the hardening liquid 10 as they flow through the main flow course pipe 26, thus forming the seamless capsules SC.

Then, the seamless capsules SC formed as described above flow down together with the hardening liquid 10 from an outlet end of the main flow course pipe 26 onto the slant perforated member 17 of the separating tank 16, and are separated from the hardening liquid 10 on the slant perforated member 17. And then, the seamless capsules SC turn around on the inclined surface of the slant perforated member 17 and are recovered into the product recovering vessel 18.

The inventions by the present inventors have been described in detail hereinabove, however the present invention should not be limited to the above embodiments, and needless to say, can be modified variously within the scope of the invention.

For example, the multiple nozzle may be a triple nozzle other than the double nozzle and various vibrating types necessary for producing the multi-layer droplets may be available. In the case of the multiple nozzle, at least one piping or multiple piping of the core liquid, encapsulating liquid and intermediate liquid may be vibrated. Of course, a single nozzle for blowing out only one layer may be used instead of the multiple nozzle.

Furthermore, any desirable ingredient or the like of the inner layer and the outer layer of the multi-layer droplets of the seamless capsule may be adopted.

Further, other constructions may be adopted as the construction of the flexible portion of the pipings 6 and/or 9.

The followings are the effects obtained by the typical ones out of the inventions disclosed in the present application.

(1) Since the vibrations are given to the flexible portion as a part of the piping, the mass is small as compared with the case where the vibrations are given to the nozzle, so that the small-sized vibrator suffices, thereby avoiding the occurrence of adverse effects due to the undesirable vibrations.

(2) The connection between the vibrator and the vibrating portion can be easily made and the both members can be provided close to each other.

(3) In comparison with the case where the nozzle is vibrated, the frequencies can be increased in the case where the flexible portion of the piping is vibrated, due to the presence of the flexible construction, and the seamless capsules having the minute particle diameters can be produced.

Claims

1. An apparatus for manufacturing seamless capsules, wherein a liquid flow for forming the capsules is blown out of a nozzle to form droplets and said droplets are brought into contact with hardening liquid to manufacture the seamless capsules, characterized in that at least a part of a piping for supplying the liquid flow for forming said capsules into said nozzle is formed of a flexible material and a vibrating means for giving vibrations to said flexible portion is provided.

2. The apparatus for manufacturing seamless capsules as set forth in claim 1, wherein said flexible portion has a diameter substantially equal to other portions of said piping.

3. The apparatus for manufacturing seamless capsules as set forth in claim 1, wherein said flexible portion is a deformed portion formed in a part of said piping.

4. The apparatus for manufacturing seamless capsules as set forth in claim 1, wherein said flexible portion is directly connected to said

nozzle.

5. The apparatus for manufacturing seamless capsules as set forth in claim 1, wherein said vibrating means gives vibrations to said flexible portion in an axial direction of said piping, in a direction perpendicularly intersecting the axial direction of said piping, or in a direction obliquely intersecting the axial direction of said piping.

6. The apparatus for manufacturing seamless capsules as set forth in claim 3, wherein said deformed portion is a bulged portion formed on said flexible portion.

7. The apparatus for manufacturing seamless capsules as set forth in claim 3, wherein said deformed portion is a spherical portion projecting from the piping at an angle to an axial direction of said piping.

8. The apparatus for manufacturing seamless capsules as set forth in claim 3, wherein said deformed portion is a hollow drum-shaped flexible portion projectingly provided in a part of said piping.

9. The apparatus for manufacturing seamless capsules as set forth in claim 3, wherein said deformed portion is a flexible portion having a substantially bellows-shape projectingly provided in a part of said piping.

10. The apparatus for manufacturing seamless capsules as set forth in claim 3, wherein said deformed portion is constituted in a part of said piping by a cup-shaped expanded portion made of a non-flexible material and a diaphragm-shaped flexible portion made of a flexible material opposed to said expanded portion.

11. The apparatus for manufacturing seamless capsules as set forth in claim 4, wherein said flexible portion is a diaphragm-shaped portion directly connected to said nozzle as a part of said piping.

FIG. 1

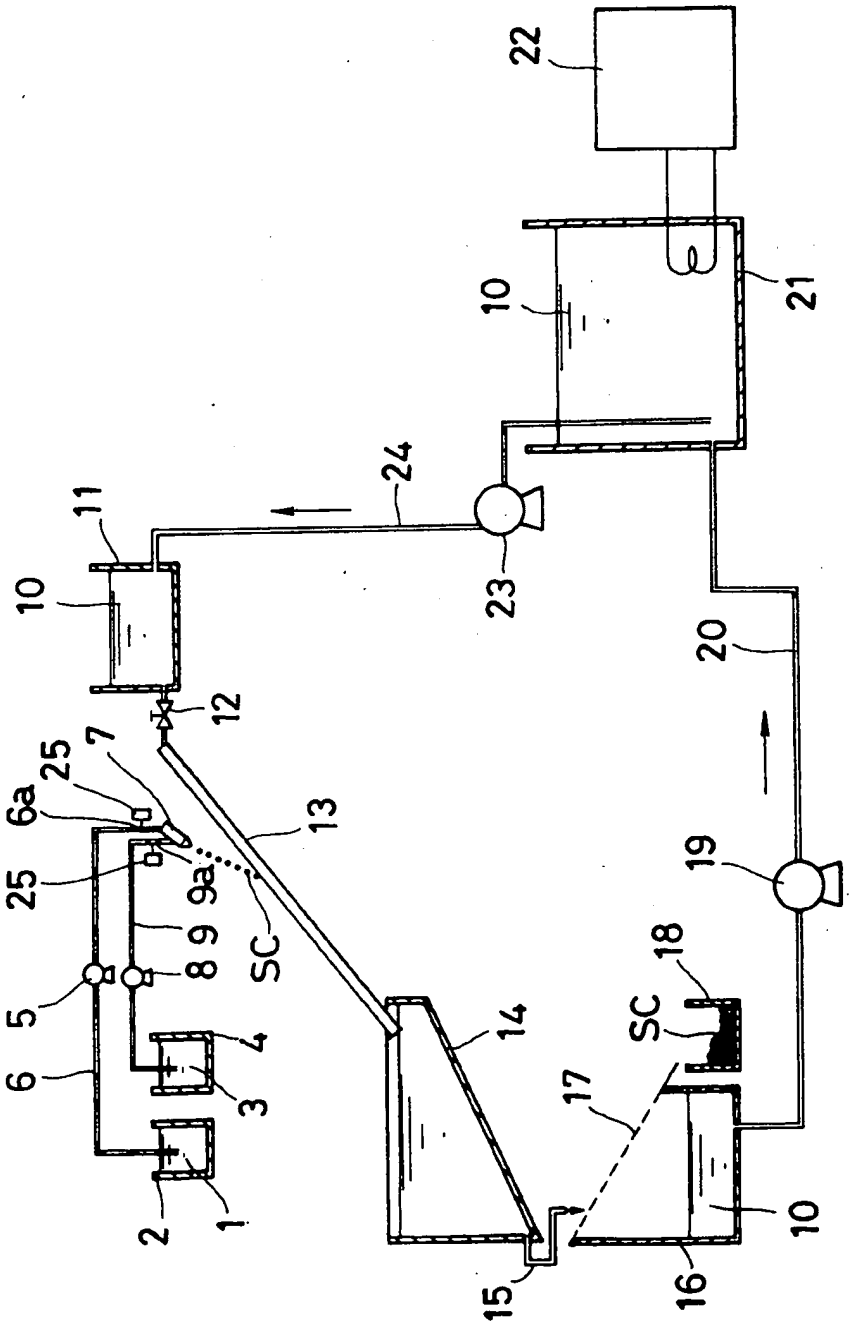
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FIG.2(a)

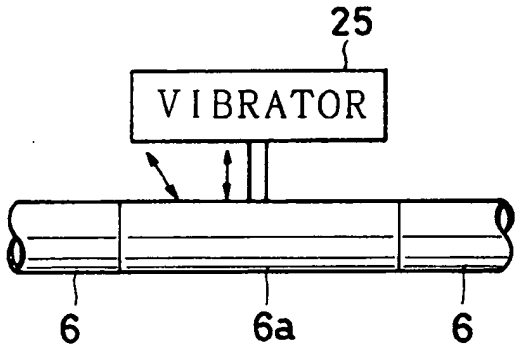


FIG.2(b)

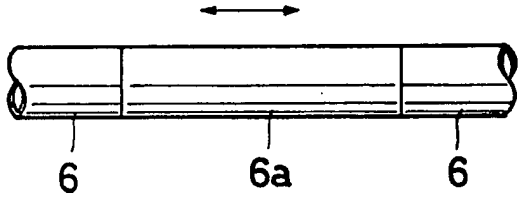


FIG.2(c)

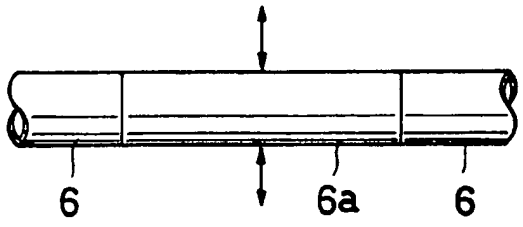


FIG. 3

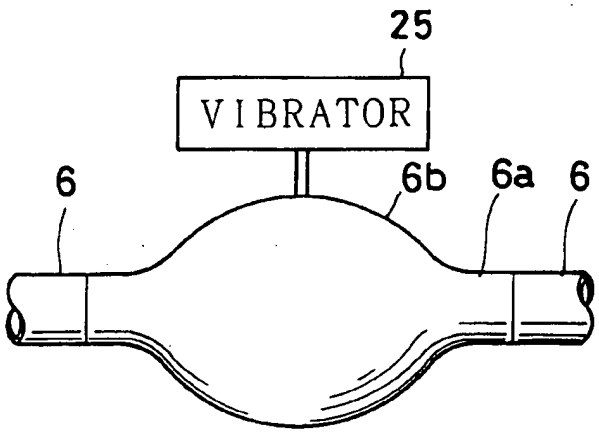


FIG. 4

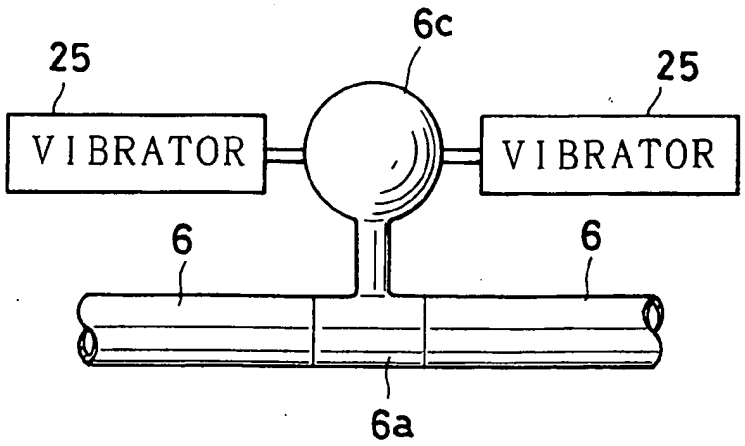


FIG. 5

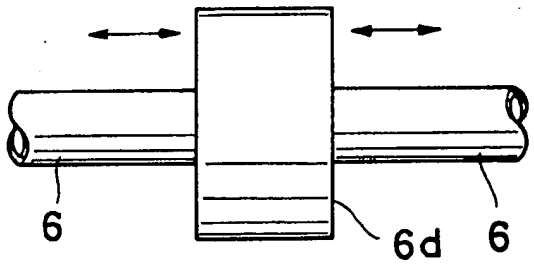


FIG. 6

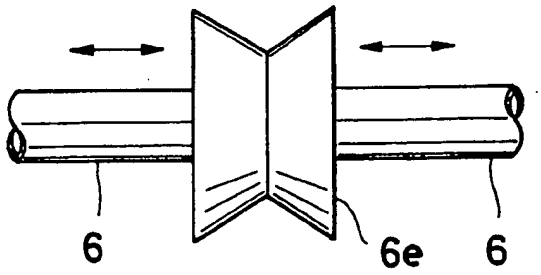


FIG.7

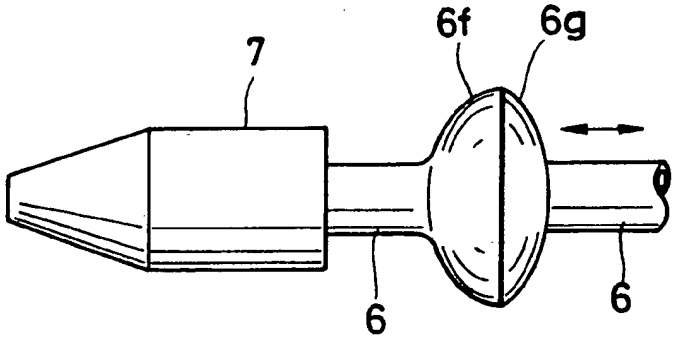


FIG.8

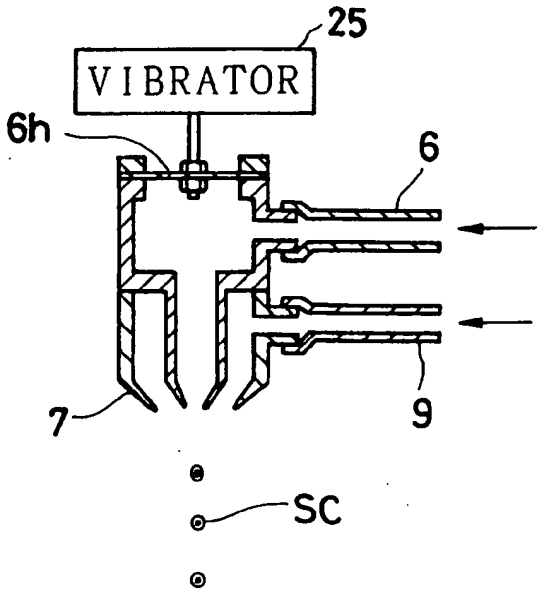
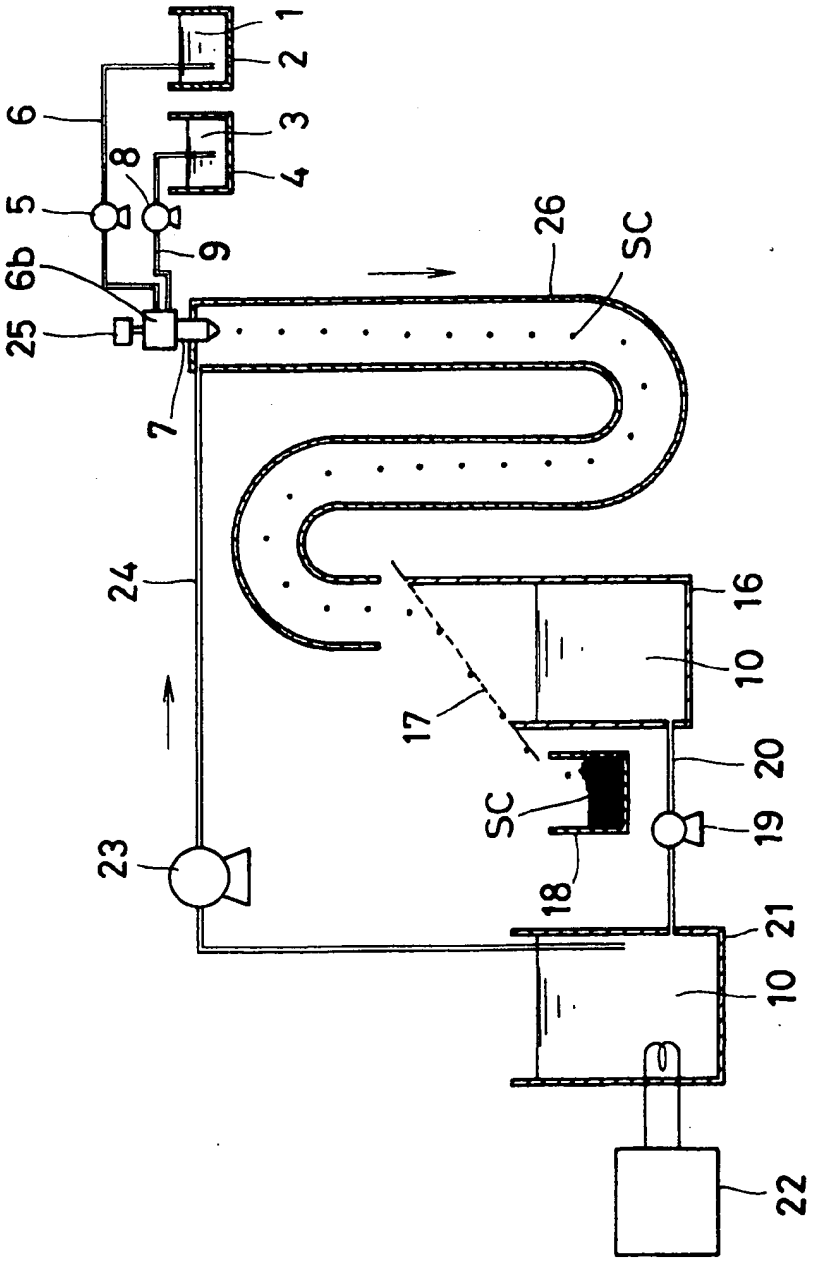


FIG. 9



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 7441

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 116 311 (MORISHITA JINTAN CO., LTD.) * page 7, line 10 - page 12, line 17; figure 3 *	1-5	B01J13/04 A61J3/07
A	DE-A-2 725 849 (HOBEG) * page 1 - page 2; claim 1; figure 1 *	1-5	
A	US-A-4 615 834 (SHIGERU YAMAGISHI ET AL.) * column 4, line 43 - line 58; figure 1 *	1-5	
A	FR-A-2 228 534 (VEREINIGTE ÖSTERREICHISCHE EISEN- UND STHAHLWERKE ALPINE MONTAN A.G.) * page 6; claim 3; figure 1 *	4	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B01J
A61J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 SEPTEMBER 1992	PYFFEROEN K.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
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